Adaptive Management for Water Operations

Note to Reviewers

The attached draft sets out the component of the BDCP Adaptive Management Program that addresses potential future changes to the conservation measure that relates to water operations (CM1). Specifically, it describes the limits within which changes to water operations criteria may occur through the adaptive management program, includes guidelines and principles to govern such changes, and proposes a process through which such decisions would be made and implemented.

The draft includes a table (Table 1) showing a set of example actions that might be implemented through the Adaptive Management Program within the adaptive limits. This table was developed as a means of establishing adaptive limits based on what is known today about possible operating criteria for various species at a variety of places in the Delta (see discussion below). We urge reviewers not to take this table as a firm proposal, but as an example of what must be eventually developed through discussions with all parties, including the permitting agencies.

The research and understanding of issues in the Delta are advancing at a rapid pace. Many of the hypotheses, such as salmonid response to OMR and smelt response to fall X2, are being tested. Our understanding of the ecology of the estuary is a dynamic and evolving process with new analyses and models emerging every year. The adaptive limits are intended to create flexibility to accommodate this new information, which will continue to emerge for decades to come.

a. Background

The BDCP adaptive management program is premised on the idea that, as new information and insight are gained during the course of plan implementation, alternative strategies can be employed to respond to uncertainty and advance the biological goals and objectives for the Plan. It is possible that the criteria and targets established for some of the BDCP conservation measures will prove inadequate, while others will produce better results than expected. Through the monitoring program, new data and up-to-date scientific information will provide greater insight and understanding of the capacity of the conservation measures to meet the goals and objectives of the Plan. The adaptive management process will afford the flexibility to allow for substantial changes, additions, and subtractions to be made to the slate of conservation measures to improve the effectiveness of the Plan over time.

As part of the adaptive management program, adjustments to water operations criteria as established by the conservation measure for water operations ("CM1") may be necessary and advisable. The BDCP identifies the specific water operations parameters that may later be changed, and defines the limits within which such changes may occur, consistent with regulatory assurances provided for under State and federal law. Adjustments that are made within these adaptive limits may result in curtailments or expansions of water supply beyond the levels initially established by CM1.

b. Concept of Adaptive Limits

The adaptive limits will serve as a kind of "contingency" or insurance fund which will allow for adjustments in the operational requirements to respond to uncertainties regarding the efficacy of the conservation measures set out in the BDCP. The attached proposal identifies the circumstances under which the adaptive management program for water operations may be triggered and adaptive changes to CM1 considered and implemented. Changes beyond the adaptive limits may be made, but such changes would be made on a voluntary basis and may require agency concurrence or permit amendments.

Through the adaptive management process, changes to CM1 could occur, both prior to or after the completion of the new isolated conveyance facility. As new information, models, and research results become available during the development of the conveyance infrastructure, for instance, CM1 may be adjusted to reflect advances in scientific understanding of the relationship between project operations and ecological conditions.

The adaptive management obligations of the permit holder are specifically identified in the conservation plan so that it is clear where the obligations of the permit holder end and where those of the State and federal agencies begin. As such, the adaptive management program will include information about the types of changes that may be made under the plan, the magnitude or extent of a potential change in a conservation measure, and the circumstances under which such changes will be required. These adaptive management actions largely represent the extent of the actions that will be required of the permit holder, consistent with the assurances provisions of the federal No Surprises rule and the NCCPA.

c. Approach to Establishing Adaptive Limits

The approach used to establish adaptive operational limits (as outlined in the attached proposal) involved three steps:

1. an evaluation of uncertainties regarding key operating parameters (those that have a potential to have a significant impact on biological resources and/or water supplies);
2. operational modeling to estimate the long-term average water supply impacts or benefits associated with modifying those parameters; and
3. establishment of aggregate "blocks" of water that maybe used to address existing and future uncertainties and certain changed circumstances.

Key operational parameters considered include:

- North Delta Bypass Flows (including pulse flow considerations)
- Freemont Weir (Yolo Bypass inundation and fish passage)
- Delta Cross Channel Operations
- OMR flows and South Delta Exports
- Head of Old River (HORB) Operable Barrier
- Delta Outflow (Fall and Spring)

While a range was considered for each of the parameters, the approach set out in this proposal does not specifically identify adaptive limits for each key operational parameter; rather it contemplates "blocks" of water that provide significant operational flexibility to respond to biological uncertainty. Moreover, for the purposes of this draft proposal, it is assumed that not all of these actions would need to be implemented concurrently. Therefore the "blocks" of water are limited to a reasonable aggregate of the contemplated actions.

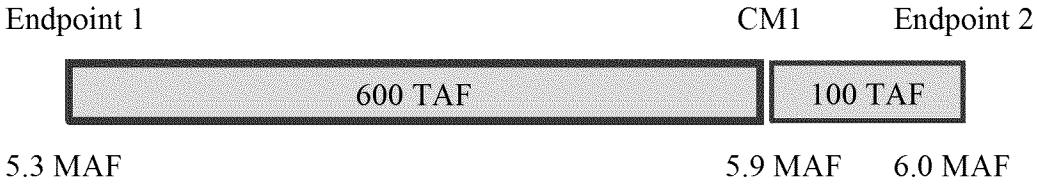
d. Applying Adaptive Limits

Once the blocks of water for adaptive limits have been specified, the blocks will be available for use in adjusting water operations through the adaptive management process. Long-term adjustments to CM 1 within the adaptive limits would not be employed on a real-time basis, but rather would be considered on a longer-term basis as part of a structured decision-making process. Decisions on any adjustments to CM1 would be based on observed ecological or biological trends. The water supply benefits or impacts related to any changes would be accounted for on a long-term average basis. A retrospective accounting would be employed on a periodic basis to ensure that the total water impact does not exceed the defined adaptive limits.

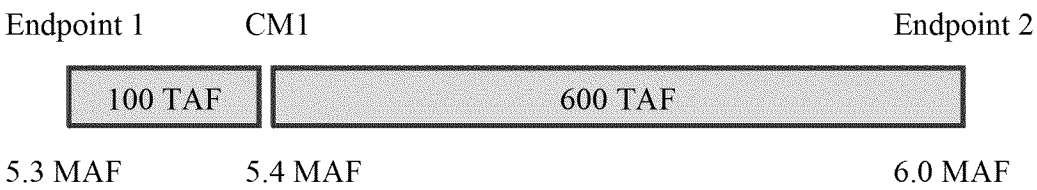
e. Defining Water Supply Blocks

The attached proposal establishes two blocks of water (one on each side of the initial CM1 operating criteria) that reflect the maximum potential loss or gain in water supply that could result from adjusting water operations. The size of each block is defined by endpoints of the adaptive limits and the initial operating criteria, which lies between the two adaptive limits. The following two examples illustrate graphically how the size of the available blocks of water could differ under two different initial operating criteria.

Example 1



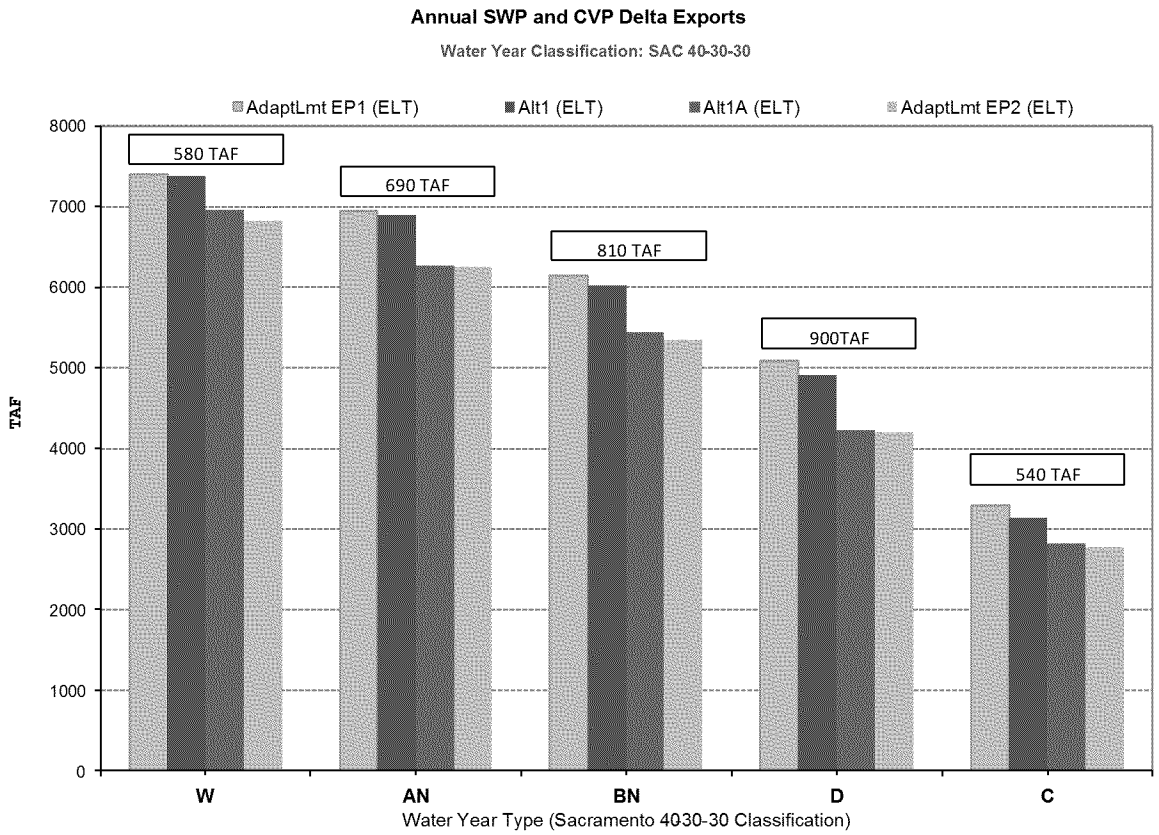
Example 2



Changes to CM1 that have a water supply impact (positive or negative) would impact the availability of water for future adjustments. For example, if additional operational restrictions were applied to Example 1 above such that the average annual yield was reduced by 100 TAF, the block of water available for any subsequent future restrictions would be reduced to 500 TAF.

The endpoints depicted in the two examples above reflect limits based on a long-term average basis. The figure below further characterizes the blocks of water available within the adaptive limits in this proposal by hydrologic water year type. The acre-feet estimates shown at the top of each water year type represent the estimated difference between the two adaptive limit endpoints for each water year type. These amounts equate to 700 TAF on a long-term average basis, as shown in the examples above. The water supply estimates associated with the different bars shown in the figure below are a function of the operating criteria assumed for each endpoint and each of the two alternative initial operating criteria, which in most cases differ depending on the water year type.

NOTE: the following figure is only an example of how the 700 TAF long term average might be distributed across hydrologic year types. Further refinement will be necessary.



ADAPTIVE MANAGEMENT PROCESS FOR WATER OPERATIONS

February 16, 2012
Working Draft
Not for Distribution

The BDCP conservation strategy sets out a comprehensive set of conservation measures that are designed to meet a range of identified, measurable biological goals and objectives. The proposed conservation measures include certain actions to improve flow conditions, increase food production, restore habitat, and reduce the adverse effects of other stressors. The BDCP conservation strategy also recognizes that, as new information and insights are gained during the course of plan implementation, alternative strategies can be employed to respond to uncertainty and advance the biological goals and objectives of the plan. It is possible that some of the criteria and targets established for BDCP conservation measures will prove inadequate, while others will produce better results than expected. To effectively address uncertainties and realize the benefit of new scientific understanding, the BDCP conservation strategy includes an adaptive management program that provides for flexibility in the implementation of the Plan's conservation actions.

To address uncertainties surrounding the effect of CVP/SWP water operations on covered aquatic species and their habitats, the adaptive management program provides a mechanism by which adjustments may potentially be made to the water operations conservation measure (CM1). The adaptive management program for CM1 would allow for additional steps to be taken to moderate risk to species, and increase the likelihood that intended outcomes will be achieved.[1] Adaptive management actions may be triggered if monitoring results or new information indicate that the initial criteria set out in CM1 has proved to be less effective than expected or that the impacts of the water operations have proved to be more significant than initially anticipated. Likewise, the adaptive management program also provides for adjustments to be made to CM1 that may result in increases to water supply in circumstances where new information reveals that available resources would be better directed toward other types of conservation actions.

In the event that the criteria of CM1 are changed through the adaptive management process, the revised criteria will be incorporated into CM1 for the duration of the plan or until such time as additional adaptive changes are adopted. The adaptive management process also contemplates that such changes to CM1 could potentially be made pending the completion of the isolated conveyance facility. Any such adjustments, however, may be made only within the defined "adaptive limits" for water operations, which reflect the extent to which operational criteria set out in CM1 may be adjusted as circumstances warrant over time. In addition, decisions to modify CM1 will be guided by the principles and conditions set out in the plan and by State and federal regulatory requirements.

This section sets out the circumstances under which changes may be made to CM1 through the adaptive management process. Specifically, it describes the approach, limits, guidelines, and

[1] Pursuant to the NCCPA, adaptive management should be used to "assist" in providing for the conservation of covered species. See Fish and Game Code section 2805(a).

processes that will used to guide adaptive management decisions affecting water operations. Among other things, this section establishes "adaptive limits" and describes the biological basis for these limits. This section also sets out principles and conditions that will serve to shape decisions regarding the appropriateness and the nature and extent of proposed adaptive responses. Lastly, this section describes the process by which such adaptive changes would be proposed, considered, and adopted, including the steps that would be taken to resolve disputes.

Development of Adaptive Limits for Water Operations

The adaptive management obligations of the Authorized Entities as they relate to water operations are specifically identified in this section of the plan. The extent of these obligations is defined by the "adaptive limits," which characterize the outer boundaries of the range of operational changes that are permissible pursuant to the adaptive management program. The adaptive limits will define, in part, the scope of regulatory assurances that will be provided pursuant to the federal No Surprises rule and the NCCPA.

Principles and Regulatory Considerations

As part of the process of determining the appropriate sideboards of the adaptive limits, the potential implications of such adaptive changes to both water supply and fish species covered by the BDCP were considered and evaluated. Adjustments made within the defined range will likely translate into additional reductions or increases to water supplies. Specifically, the adaptive limits for water operations reflect the following policy and regulatory considerations:

- The adaptive limits are compatible with the BDCP goal to restore and protect ecosystem health, water supply, and water quality within a stable regulatory framework.

- The adaptive limits reflect the degree of scientific uncertainty and potential risk associated with gaps in data and information regarding the effect of the BDCP actions on covered species.

- The adaptive limits provide for operational changes that are practicable and commensurate with the impacts of the covered activities.

- The adaptive limits provide sufficient flexibility to address current and ongoing uncertainties and data gaps regarding the species covered by the plan; however, they are not so broad so as to render regulatory assurances meaningless.

Approach to Characterizing and Setting the Adaptive Limits

The adaptive limits are described as the upper and lower amount of water that would be available to vary the operation criteria in CM1. The approach provides clarity and certainty, establishing a straightforward, unequivocal metric for the total amount of water (in acre feet) that would be available for adaptive changes to water operations. It simplifies the process of implementing adaptive changes to water operations, allowing for substantial flexibility in determining the most effective adjustments to operational parameters that could be made in response to particular

circumstances. The approach also offers advantages related to plan implementation, particularly with respect to accounting for, measuring, and tracking (which would be measured through the use of supply reliability curves) those actions taken pursuant to the adaptive management program.

Adaptive operational limits are based on:

1. an evaluation of uncertainties regarding key operating parameters (those that have a potential to have a significant impact on biological resources and/or water supplies);
2. operational modeling to estimate the long-term average water supply impacts or benefits associated with modifying those parameters; and
3. establishment of aggregate blocks of water that can be used to address existing uncertainties, different future uncertainties, and other changes in the future.

The following parameters were considered in defining appropriate boundaries for operational changes:

- North Delta Bypass Flows (including pulse flow considerations)
- Freemont Weir Operations (including Yolo bypass inundation and fish passage)
- Delta Cross Channel Operations
- Old and Middle River Flows/South Delta Exports
- Head of Old River Barrier
- Delta Outflow (fall and spring)

For each of these parameters, a specific operational range was developed based on existing or anticipated uncertainties regarding the effect of water operations on biological resources and/or water supplies. Table 1 sets out each of the operation parameters considered and the limits established for each for the purposes of estimating blocks of water that would reflect the existing levels of uncertainty. Table 1 depicts the water supply quantities associated with the blocks of water. One end of the range, or "Endpoint 1," describes the limits of operational changes that have the effect of restricting water supply availability beyond those required under CM1. Similarly, the other end of the range, or "Endpoint 2," sets out operational changes that would result in less supply restrictions. The estimated long-term average annual water supply associated with operating all the parameters at Endpoint 1 is 5.3 MAF. The estimated long-term average annual water supply associated with operating all the parameters at Endpoint 2 is 6.0 MAF.

The water supply estimates associated with each endpoint are used to establish two blocks of water (one on each side of the initial CM1 operating criteria) that reflect maximum potential losses or gains in water supply that could occur over the life of the Plan. The water supply loss or gain that can result from moving toward Endpoint 1 or Endpoint 2 respectively is defined by the initial operating criteria, which lies between the two endpoints. These two potential water supply effects are used to establish the two blocks of water available to modify CM1 within the bounds of the adaptive limits.

Table 1 shows the derivation of the adaptive limits. The purpose of the table is to show the origin of an overall adaptive range. While the end points are derived based on current understanding of the effect of various operational scenarios identified during the development of the BDCP, the

table does not assume specific operational restrictions in any given region of the Delta. The operative effect of the Table is reflected in the overall endpoints, which constitute the adaptive limits. Adaptive changes to CM1 may not affect long-term average annual water supply beyond the range of 5.3 to 6.0 MAF. Operations would not be constrained beyond a long-term average annual supply of 5.3 MAF. Similarly, exports would not rise above a long-term average annual supply of 6.0 MAF. Within these bounds, proposals to change the operating restrictions in all parts of the Delta could be considered as long as the result of these restrictions did not exceed either end of the adaptive range.

Summary of Key Areas of Uncertainty

Table 2 below lists the water operations parameters considered in developing the adaptive limits and the species and life-stages they may influence. Specific areas of uncertainty related to each of the operational parameters are detailed following Table 2.

North Delta Diversion Bypass Flows**:** The purpose of the north Delta diversion bypass (NDDB) flows is to facilitate successful migration of fish past the intakes and to contribute to habitat suitability in the Sacramento River downstream of the diversion structures. The proposed north Delta bypass flows under CM1 are intended to provide baseflows in the Sacramento River, as well as respond to changes in river flows that occur during the juvenile salmonid migration and rearing period in the lower reaches of the Sacramento River. For purposes of developing the adaptive limit it is assumed that the north Delta diversion constant low-level pumping would be limited to a range of 2% to 10% of the Freeport flow.

The period of juvenile salmonid passage and in-river rearing assumed in establishing CM1 reflects current information on the seasonal migration patterns for all four runs of Chinook salmon as well as steelhead produced in the Sacramento River watershed. Results of future monitoring are expected to provide additional information that can be used to refine the period of juvenile migration and variation among and within years in response to hydrologic conditions including pulse flow events.

Managed Fremont Weir Flows: The goal of the Fremont Weir flows is to increase the frequency and duration of Yolo Bypass inundation to intermittently enhance juvenile salmon growth and survival (Sommer et al. 2005), improve splittail recruitment (Feyrer et al. 2006), and provide a seasonal infusion of prey to fishes inhabiting the Cache Slough region, particularly during floodplain drainage (Lehman et al. 2008).Management of Fremont Weir flows is also expected to facilitate adult passage of salmonids and sturgeon following modification of the Fremont Weir (BDCP CM2).

The range of conditions considered in developing the adaptive limits included flows onto the Yolo Bypass from the Sacramento River from 3,000 cfs to 6,000 cfs. Monitoring studies are expected to provide additional information that can be used to assess the biological benefits of seasonal floodplain inundation over a range of flows and durations of inundation. The studies will not only assess the effects of inundation from the Sacramento River via the Freemont Weir

Table 1. Derivation of BDCP Water Operations End Points[2]

Region	Operations Criterion	End Point 1	End Point 2
North Delta	NDD Constant Low-Level Pumping	2% of Freeport flows diverted	10% of Freeport flows diverted
	NDD Initial Pulse Protection	No increase in pumping during initial pulse	No initial pulse protection
	NDD Bypass Flows	Level I pumping following pulse flow protection, Oct-May; Level II thereafter	Level II pumping after 10 days of Q > 20 kcfs; Level III after 20 days of Q > 20 kcfs
	Fremont Weir: Yolo Bypass Inundation Flows	Up to 6,000 cfs and extended through May 15	Up to 3,000 cfs through March 31
	Fremont Weir: Adult Fish Passage Flows	500 cfs	300 cfs
	Delta Cross Channel Operations	0% open Dec-Jun; 100% open Jul-Sep; 0% open Oct-Nov	D1641 criteria with additional closures per NMFS BO
South Delta	Old and Middle River Flows	Per Scenario 6	No less than negative 6,000 cfs (Dec 20 – Jun 30)
	Fall San Joaquin Pulse Flow Protection (Oct-Nov)	Per Scenario 6	None
	Operable Head of Old River Barrier	Per Scenario 6	Per BiOps
Delta-Wide Indicators	Fall Delta Outflow (Sept-Nov)	(see footnote)[3]	None
	Spring Delta Outflow (Feb-Jun)	D-1641 criteria	D-1641 criteria
	Export/Inflow Ratio	D-1641 criteria as applied to total inflow and *total* SWP and CVP exports	D-1641 criteria as applied to total inflow and total SWP and CVP *south* Delta exports
Annual SWP and CVP Exports		5.3 MAF	6.0 MAF

[2] Table 1 is for the purposes of helping to estimate appropriate blocks of water only. It serves no purpose for implementation once the blocks are established.

[3]The reasonable and prudent alternative (RPA) included in the existing biological opinion requires the implementation of the Fall Delta Outflow criteria in every wet and above normal year, with an impact on long-term average annual water supply of approximately 300,000 AF. The impact on long-term average annual water supply of implementing this RPA every other wet and above normal year, in an attempt to test the effectiveness of the RPA in a scientific way, would be approximately 175,000 AFA. Although the RPA is presently in effect, a great deal of data was collected in 2011 regarding the effectiveness of the RPA. In addition, various models of the life cycle of Delta Smelt (a key species affected by Fall Delta Outflow) are in development which may ultimately affect the degree and nature of implementation of this RPA. For purposes of this table, it is assumed that the RPA would be implemented every other wet and above normal year.

Table 2. Water Operations Parameters and Related Species Uncertainties

Region	*Operations criterion*	*Species and life stage(s) affected*
North Delta	North Delta diversion bypass flows	• Juvenile salmonids and sturgeon • Possibly survival of juvenile splittail, lamprey, and migrating adult delta smelt.
	Protection of Sacramento River pulse flows (magnitude and duration)	• Juvenile salmonids and sturgeon; • Possibly survival of juvenile splittail and lamprey.
	Fremont Weir flows	• Splittail spawning and incubation; • Juvenile salmon survival and rearing habitat; • Larval delta smelt food supply • Adult salmonids, sturgeon, and lamprey;
	Delta Cross Channel Operations	• Juvenile salmon straying • Mokelumne adult salmon straying
South Delta	Old and Middle River flows	• Delta and longfin smelt and San Joaquin Basin salmonid entrainment risk
	D-1641 fall pulse flow on the San Joaquin River	• San Joaquin River fall-run Chinook salmon attraction flows
	Operable Head of Old River Barrier	• Juvenile San Joaquin River salmonids and possibly splittail spawned in the SJR.
	South Delta export rates	• Delta and longfin smelt and San Joaquin Basin salmonid entrainment risk • San Joaquin basin fall-run Chinook salmon attraction flows.
Delta-wide indicators	Delta outflow (X2)	• All covered fish species.
	Total Export: Total Inflow	• Indirectly reflects parameters such as OMR reverse flows, Delta inflow and outflow, and other factors that have been associated with conditions in the Delta.

but also assess the contribution of various tributaries to habitat conditions within the Yolo Bypass.

Observations under current conditions have also demonstrated that adult fish may migrate upstream into the Bypass and be trapped by lack of a suitable fish ladder at the Freemont Weir. Fish that are trapped by the weir and cannot migrate upstream are vulnerable to mortality from predation, illegal harvest, and other sources. For purposes of evaluating a range of conditions, flows through one or more fish ladders at the Freemont were assumed to range from 300 to 500 cfs. Fish ladders would be designed to meet upstream fish passage conditions at 300 cfs but would include provisions for increased flows as needed based on fish ladder performance for various covered fish species.

Delta Cross Channel: The primary goal of Delta Cross Channel gate operations is to reduce the fraction of juvenile salmonids emigrating from the Sacramento River mainstem that migrate into the interior Delta, where their survival can be impaired (Brandes and McLain 2001; Newman and Rice 2002; Newman 2008).Closure of the Delta Cross Channel gates contributes to a reduction in flow from the Sacramento River, and passage of juvenile and adult fish into the interior Delta, as well as an increase in flows in the lower Sacramento River that may be beneficial to improving fish transport, survival, and attraction/olfactory cues for upstream adult migration. Closure of the Delta Cross Channel gates is most biologically meaningful in the late winter and spring months when juvenile salmon, steelhead, delta and longfin smelt, and other fish are present in the lower Sacramento River.

Preliminary results of recent experimental tests also suggest that closure of the Delta Cross Channel gates in the fall months contributes to improved attraction flows and olfactory cues that reduce straying of adult Chinook salmon from the Mokelumne River into the Sacramento River and contributes to increased abundance of adult salmon (and possibly other fish) to the eastside tributaries.

For purposes of developing the upper range of adaptive limits it has been assumed that the Delta Cross Channel would be closed (100% of time) for the period from October through June each year, and open from July to September. Closure of the Delta Cross Channel gates during the fall months (October-December) has the potential to benefit adult fall-run Chinook salmon and possibly steelhead attraction and migration cues, while gate closures January through June are expected to contribute to a reduction in the passage of juvenile salmon, steelhead, and other fish from the Sacramento River into the interior Delta where mortality rates have been shown to be higher, as well as contribute to additional flow in the lower Sacramento River that would contribute to increase downstream transport of larval delta and longfin smelt.

Old and Middle River Flows: The goals of the Old and Middle River flow criteria (OMR) are to contribute to lower fish entrainment in the southern Delta, improve migration cues (e.g., net downstream flows) within the central and south Delta, and to increase native fish survival in the interior Delta by increasing the recurrence frequency of net downstream flows in the south Delta. There is no substantive scientific disagreement that reverse flows influence fish entrainment or that some reverse flow management is desirable. Data analysis and experimental studies are being conducted to provide greater insight into the relationship between OMR reverse flow

magnitude and seasonal timing and effects on survival, migration rate, and migration route selection within the lower San Joaquin River as it passes through the Delta.

There have been a wide range of OMR flow proposals for BDCP. Proposals for OMR adaptive limits have ranged from unvarying monthly OMR limits to flexible OMR limits that vary depending on water-year type or modeled Delta inflows. The inflow-based rules are the most flexible in terms of responsiveness to modeled hydrology. Thus, they are best suited to balancing fish protection and water supply reliability in CALSIM-2.

Based on results of various modeling analyses and consideration of the interaction between OMR flows and fish entrainment/salvage at the south Delta SWP and CVP export facilities the lower range of adaptive limits (most restrictive OMR reverse flow conditions – less negative OMR) assumed in these analyses are those outlined in Scenario 6.

Head of Old River Barrier: The goal of an operable Head of Old River barrier (HORB) is to increase the survival of juvenile salmonids emigrating from San Joaquin River tributaries during spring and to increase the homing and attraction of adult Chinook salmon during the fall. The HORB may also increase the survival of juvenile splittail produced in the San Joaquin River. The empirical support for improved Chinook salmon survival was summarized by Newman (2008). The barrier may not be needed in the future if Old River is isolated from the effects of South Delta diversions. The non-physical (bubble) barrier (or alternative guidance technologies), analogous to 100% open, is included within the adaptive range.

Delta Outflow and X2 during later Winter, Spring, and Fall: The goal of managing Delta outflow is to contribute to increased estuarine habitat suitability that supports the successful migration and production of multiple species and their supporting food web. Operations proposed under BDCP and the adaptive limits are based on maintaining late winter and spring Delta outflow and X2 locations as prescribed under D-1641 under all scenarios. There is uncertainty, however, in the biological response of pre-spawning delta smelt to the location of X2 during the fall. As new scientific information becomes available in the future regarding the locations and biological response of delta smelt to fall X2 conditions refinements to future Delta outflow and fall X2 locations in the fall may be identified.

The adaptive limits do not prescribe a specific fall X2 management strategy at this time. The USFWS fall X2 RPA which prescribed management of X2 during September and October in wet and above normal water years at specified locations in Suisun Bay and the western Delta has been used to help identify one potential management condition that could potentially be implemented in the future. The USFWS RPA would be implemented in every other qualifying year to better determine through scientific analysis what the real benefits of the location of Fall X2 actually are. Results of the hydrologic analysis were used to assess the potential contribution of modification to fall X2 in developing the proposed upper range of the adaptive limits shown in Table 1.As new scientific information becomes available other potential fall operations, including no fall X2 management, may be identified based on the biological response of delta smelt. The adaptive limits recognize the need for flexible future operations to accommodate changes in management response based on new scientific information.

North and South Delta Export to Inflow Ratio: With an additional point of diversion in the Sacramento River, results of future scientific investigations and analyses may identify desirable refinements or revisions to the Delta export to inflow ratio (E/I) regulated by D-1641. The proposed project water operations have been created and modeled with an E/I ratio that measures inflow only below the north Delta diversions and does not include north Delta diversions as exports. SWRCB D-1641 included provisions for regulating the seasonal SWP and CVP export rates as a percentage of total Delta inflow (referred to as the E:I ratio).The E:I ratio is limited to 35% exports during the winter and spring (February-June) and 65% exports between July and January. The objective of this condition was to maintain a balance between the export rate and the Delta inflow rate, particularly during the winter and spring when the majority of sensitive lifestages of covered fish are present within the Delta. As new scientific investigations and analyses are completed in the future, refinements to the E:I ratio concept or the formulation for how total Delta inflows and exports are accounted for in determining the E:I ratio under dual facility operations may be identified. Although the adaptive limits do not prescribe specific modifications to the E:I ratio in the future, the adaptive limits are designed to allow future flexibility to accommodate new information and refinements or revisions to export operations at the north and south Delta diversions in relationship to hydrologic conditions occurring within the Central Valley watershed as reflected by Delta inflow or other metrics.

Process and Approach to Adaptive Management Decision-making

Initiation of the Adaptive Management Program for Water Operations

Generally, the determination regarding the need to initiate the adaptive management process for water operations will occur in association with the development of the Annual Operations Plan.[4] At that time, data and information derived from the monitoring program and from other sources will be assessed to determine whether conditions and circumstances indicate a need for the considerations of adaptive responses.

Under the adaptive management process for water operations, the occurrence of any of the following conditions will be considered sufficient to warrant the initiation of the adaptive management process:

- Indicators (identify specific metrics) of lack of progress, over a sufficiently long monitoring period, toward meeting biological objectives associated with water operations (*e.g.*, measures/metrics identified in biological goals and objectives).

- Indicators of a greater than expected impact of water operations on covered species and/or their habitats.

[4] The adaptive management process for water operations is separate and distinct from the "voluntary operations mechanism" that allows for real time operational changes. Operational changes that occur through this voluntary mechanism will fall within the criteria established for CM1. Adaptive changes, on the other hand, would involve adjustments to CM1 criteria, within the sideboards of the adaptive limits.

- Indicators of a lack of effectiveness of all or parts of CM1 (taking into account the overall effectiveness of the plan's conservation measures).

- Occurrence of a changed circumstance that contemplates a response affecting water operations.

Performance metrics will be used to help gauge the progress of the plan toward meeting the biological objectives of the plan. Knowledge gained from monitoring and research regarding the implementation of the BDCP conservation measures and from other sources will be reviewed on an annual basis to determine the need to develop modified operational criteria to improve effectiveness of the water operations conservation measure. Performance metrics serve as indicators that intended biological goals and objectives are not likely to be achieved and that adaptive changes may need to be considered and adopted. For biological objectives where precise metrics are not feasible or applicable, other means of measuring progress will need to be employed.

The Adaptive Management Team will be responsible for assessing whether there is sufficient indication that any of the foregoing conditions has occurred. The Adaptive Management Team will draw from monitoring and other data and information that has been analyzed and synthesized at appropriate intervals by the Implementation Office, in coordination with Delta Science Program and IEP. This analysis will include information related to cause and effect relationships between conservation measures and ecological processes, covered species, and natural communities; the status of ecosystem conditions and covered species; and the effectiveness of the conservation measures and monitoring program. The results will also identify the inferential reliability of this knowledge, statistical performance measures (e.g. power, accuracy, precision) and, if appropriate, alternative hypotheses generated from the results. Information gained through this process may indicate the need to redefine hypotheses underlying the operational criteria contained in CM1 to advance the biological objectives; refine, discontinue, expand operational criteria specified in CM1; or develop and implement new conservation measures within the limits set by the plan and its associated regulatory authorizations.

Upon reviewing such scientific data and information, the Adaptive Management Team will document their findings, including the data and information relied upon, and submit their recommendations to the Implementation Board and the Permit Oversight Group for consideration. The Implementation Board and the Permit Oversight Group will jointly determine whether the adaptive management process for water operations should be initiated.

Approach to Changing Water Operations within the Adaptive Limits

The determination of the extent to which operational changes may be made through adaptive management – that is, the total quantity of water that would be available for such purposes – will be guided by certain requirements. The following sets out the process and guidelines that will be used in making determinations about appropriate adaptive management changes to water operations.

The approach to changing water operations within the adaptive limits involves the use of a defined decision-making process guided by conditions which outline the circumstances under which the adaptive management process may be invoked and establish certain limitations on the nature and magnitude of any resulting change. The procedural steps and substantive constraints are shaped by the following guidelines:

1. General Circumstances under which Adaptive Changes may be Appropriate: Adaptive changes to water operations may be implemented only if one or more of the following occurs: 1) substantial progress toward meeting biological goals and objectives is not being achieved or that progress has exceeded expectations; 2) new information or data becomes available that suggests that BDCP water operations are having a greater or lesser effect on species than initially anticipated; 3) a changed circumstance has occurred that necessitates modifications to water operations; 4) information suggests that the adoption of alternative, non-water operations related conservation measures would be more effective at advancing biological goals and objectives.

2. Causal Relationship between BDCP Actions and Ecological Conditions. Sufficient causal links must be established, to the extent feasible, between BDCP covered activities and the condition for which the adaptive change is being sought (*i.e.*, "proximate cause" test). That is, the BDCP actions must be the proximate cause of the circumstances triggering the adaptive management process. In instances where such causal links cannot be clearly established, the BDCP Science Manager and the fish and wildlife agencies will jointly document the rationale for the adaptive change, including the steps that will be taken to develop data and information necessary to ultimately establish such a causal link.

3. Biological Rationale. Any modifications to the operations criteria should be reasonably likely to produce a beneficial biological response. Such determinations will be based on the best available scientific information. In some instances, the BDCP Science Manager may convene independent scientists to help assess the likely biological benefit of the proposed adaptive change. Prior to any adjustment to CM1, the BDCP Science Manager and the fish and wildlife agencies will jointly document the scientific rationale for the proposed change.

4. Commensurate with Impact. Proposed operational adaptive responses must be commensurate with the newly-determined incremental impact or the incremental decline attributable to water operations. As part of the process of determining the appropriate magnitude of response, the Implementation Board and the fish and wildlife agencies must take into account the degree to which the BDCP action is responsible for the impact or decline, and adjust the proposed response to ensure proportionality and effect and consistency with the standards set out in the ESA and the NCCPA.

5. Consequences of Proposed Modifications. Prior to the modification of the water operations criteria, the expected consequences of the proposed adaptive change must be evaluated. The assessment of such consequences will help ensure that resources available through the adaptive management program are used efficiently and effectively. For instance, certain changes may result in minimal impacts to water supply, but may be

expected to produce substantial biological benefits. Other changes may be expected to produce marginal biological benefit, but require substantial quantities of water. In some cases, alternative strategies may be available that are of equal biological value, but one is more cost-effective than the other. In such cases, the more cost-effective of the strategies should be adopted.

6. Type of Adaptive Response. The consideration of proposed adaptive changes to CM1 must include an assessment of alternative non-operations responses that could potentially be adopted. As such, proposals to modify CM1 must include the reasons why non-operational responses, such as additional habitat restoration actions, would not be sufficient to address the ecological conditions at hand.

Approach to Decision-making and Dispute Resolution

The BDCP governance structure includes a well-defined framework for adaptive management decision-making. The following sets out the roles and responsibilities of the Implementation Board, the Permit Oversight Group, Implementation Office, and the other relevant parties as they relate to adaptive management decisions affecting water operations. This section further describes the steps that would be taken to resolve disputes that may arise in connection with proposed adaptive changes to water operations criteria.

1. Initiation of the Adaptive Management Process. On an annual basis, the Program Manager will be responsible for convening the Adaptive Management Team (which consists of scientists from the Implementation Office, including the Science Manager, IEP; water agencies; and stakeholder groups) to consider whether conditions warrant the initiation of the adaptive management process for water operations.

   The Adaptive Management Team, after reviewing the relevant data and information and after receiving input from the Authorized Entities, the fish and wildlife agencies, and the Stakeholder Council, will assess relevant conditions and provide the Implementation Board and the Permit Oversight Group with its recommendation, including the specific reasons for the recommendation, as to whether the adaptive management process should proceed.

   The Implementation Board and the Permit Oversight Group will convene to consider the recommendation of the Adaptive Management Team. As part of their deliberations, the Implementation Board and Permit Oversight Group may seek input from independent scientists. If the Implementation Board and Permit Oversight Group agree that conditions or circumstances warrant an adaptive response, the Adaptive Management Team will begin to develop a proposed approach. If the Implementation Board and the Permit Oversight Group are unable to reach such agreement, the dispute resolution process will be invoked.

2. Development of Recommended Adaptive Changes to Water Operations. Once a decision is made to proceed with the adaptive management process, the Adaptive Management Team will develop a recommended response within the adaptive limits. The Adaptive

Management Team will analyze the physical, ecosystem processes, and biological variables associated with potential operational changes (including the strength of the causal relationship between the BDCP actions and the ecological circumstances at issue). Other considerations, such as policy, legal, and regulatory principles, would be addressed by the Implementation Board and the Permit Oversight Group. Any interested party, including the Authorized Entities, the fish and wildlife agencies, and stakeholders, may forward proposed approaches to the Adaptive Management Team for consideration.

The Adaptive Management Team will, within 90 days, submit in writing to the Implementation Board and the Permit Oversight Group recommended adaptive response. The recommendation will include a description of the proposed operational change, if any; the extent, magnitude, and timing of the proposed modifications to water operation criteria; and the scientific rationale for the proposed change. The recommendation will also include an analysis of the causal linkages between the biological condition and BDCP activities and a discussion of the other non-water operations measures that were considered and the reasons why such measures are not being proposed.

In the event that the Adaptive Management Team is unable to reach consensus on an approach, the Science Manager will report to the Implementation Board and Permit Oversight Group on the nature of the disagreement and the Science Manager's individual judgment regarding the appropriate course of action.

3. Adoption of Adaptive Changes to Water Operations Criteria. The Implementation Board and the Permit Oversight Group will jointly meet to consider and act on the recommendations of the Adaptive Management Team. As part of these deliberations, the parties will identify and take into account the policy, legal, and regulatory principles established in this section to guide such decisions. If the Implementation Board and Permit Oversight Group agree that the proposed operational changes are warranted, the relevant operational criteria in CM1 will be modified and such changes implemented as directed. The Program Manager will be responsible for documenting any changes made to CM1.

   In the event that the Implementation Board and the Permit Oversight Group are unable to come to an agreement on the adaptive change to be implemented, the parties will jointly select and convene a group of outside scientists to make independent recommendations. If either the Implementation Board or the Permit Oversight Group rejects the recommendations of the independent science group, the dispute resolution process will automatically be triggered. If neither reject the recommendations of the group, those recommendations will be implemented.

4. Dispute Resolution Process for Adaptive Changes to Water Operations. A dispute resolution process would be initiated in circumstances in which the Implementation Board and the Permit Oversight Group were unable to reach agreement 1) on whether the adaptive management process should be initiated on the basis of a triggering event or condition, or 2) on the nature or magnitude of a specific change recommended by the Adaptive Management Team. In such an event, the parties, with the assistance of the

Program Manager and the Science Manager, would describe the basis for the dispute and propose options for its resolution. The matter would then be elevated, in an orderly and timely manner, to the highest ranking responsible officials, be it a federal or State cabinet-level official or their designee (i.e., the Departments of Commerce and/or Interior), or the California governor.

If the highest ranking federal and/or State officials are unable to resolve the issue at hand, the Implementation Board would proceed with the action it deemed appropriate. However, the fish and wildlife agencies would each consider whether such action would be in compliance with the terms and conditions of the BDCP, its Implementing Agreement, and the associated regulatory authorizations.